



The Role of Waste Reduction Technology in Sustainable Recycling of Waste Paper at Thi-Qar University



Noor Najm¹ , Mustafa M. Mansour^{2*} 

¹ Department of Petroleum and Gas Engineering, College of Engineering, University of Thi-Qar, Thi-Qar 64001, Iraq

² Department of Mechanical Engineering, College of Engineering, University of Thi-Qar, Thi-Qar 64001, Iraq

Corresponding Author Email: mustafa.muhammedali@utq.edu.iq

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ABSTRACT

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The purpose of this study is reducing sustainable paper recycling at Thi-Qar University by using waste reduction techniques. It can be argued with much confidence that the idea of recycling paper can be successfully implemented in an academic institution. This can be done by merging the specific waste paper baskets, pulping machine and power from a renewable source with an already established local paper making company. The methods applied in this study are making company would be able to recoup a government subsidy that pays them to recycle paper in order to offset the cost of pulped paper which is 30% more expensive than raw wood pulp. The academic institution that implements this would save money on waste disposal, and cut its carbon footprint in half, by up to 600%, per year approximately five-six tons of CO₂ instead of one-ton-two tones carbon offset for simply recycling the paper. All these steps could also be applied for recycling of the large amount of waste papers generated by students an idea that encounters high costs in recycling hence being rarely implemented. This could be achieved through urged use of the same paper disposal methods already in use, where the paper collected is pulped from the student paper waste bins once a week. The results of this article are more specific yet indirect environmental benefit concerns the recycling habits of students. By providing the means for students to recycle paper at their places of study, it is hoped that they will adopt similar practices in their homes and other areas of life and show that the practice of paper recycling at Thi-Qar University has a success rate of 98.42%. Additionally, a total revenue of \$3,527.98 was collected from the value of recycled paper. This can be important, as it is today's young people who will shape the future condition of the environment. If a more conscientious attitude towards recycling can be established, the cumulative environmental benefits could be very significant. On the economic side, recycling paper can potentially save academic institutions a substantial amount of money on their waste disposal. This is because paper and cardboard often make up a high percentage of the waste and these are materials which can be recycled relatively cheaply. By decreasing the volume of general waste, a decrease in waste disposal costs can be achieved. If institutions take it a step further and decide to purchase only recycled paper products, this can also help accelerate the demand for recycled paper and its long-term economic feasibility. The benefits of paper recycling in academic institutions are undoubtedly far-reaching. Not only are the environmental benefits significant, but also the potential cost savings and impact on student attitudes. Probably the most apparent benefits of paper recycling are the environmental ones. The significance of this research is recycling paper in academic institutions is not only beneficial to the environment but also has potential cost-saving implications and significant educational value for students' attitudes.

1. INTRODUCTION

The aim of this work is to discuss the existing literature on waste reduction technologies that have been successfully employed in paper production. This survey also improves the waste record and how this narrative is used to enhance the project. In this way, the main goals are: (i). Using waste reduction technology to maintain sustainable paper recycling at the University of Thi-Qar. The fact that this project is formulated in such a way means that it will not only assess the

offerings made and the aid offered in particular but also provide a larger review of the advantages and significance of this program [1]. (ii). Determine the advantages of resources offered for this waste reduction technology for one significant institution, i.e., Thi-Qar University, as a case. (iii). To establish verified data in assisting operations, beneficial information relating to the savings made by this project while also thinking about the future of this application [2]. Conclusively, this report provides: - Comprehensive reviews have been carried out on publications related to this project

and on the contributions made shown. - A brief summary of the work is presented and is related to other topics not discussed in this report as well as providing possible sources of support. Given the chance, this project will go on to receive a grant. In this chapter, there is a brief but detailed explanation and clues as to what enhancements are to be made. As a budget will be proposed, reviewing this document can provide a forecast of expenditures and savings to be produced [3].

Taking care of the environment today is something common to do, and every individual and all institutions and their educational, health, and other services share in this regard as much as they can. Recycling paper is one of the important aspects of reducing waste in the environment and one of the best choices for recycling sources [4]. As a result, this paper discusses the use of waste reduction technology as an essential element in continuously saving paper at the University of Thi-Qar (Figure 1).



Figure 1. Towards a practical powerless ZnO nanorods touch sensor fabricated on silicon and a flexible polyamide substrate [5]

These have been noted widely and it is generally accepted that it is more sustainable to recycle paper than to send it to landfill or incinerate it. By doing so, deforestation can be decreased along with the many environmental effects that result from it. It is the same story with regards to energy - the amount of energy saved from recycling paper as opposed to making it fresh is reported as being up to 60%. This subsequently means less burning of fossil fuels and less impact on the world's climate. The result of this is a reduction in the release of greenhouse gases, which can further alleviate the effects of global warming and climate change [6].

1.1 Purpose of the study

This study aims to look into identifying and introducing the use of significantly sustainable paper-recycling technique and motivating the use of the same in academic institutions. The study anticipates a substantial change in paper-recycling methods from the very basic "waste paper collection" technique to a more advanced and environmentally effective technique such as "vermicomposting of waste paper". The objective is to reduce the quantity of paper-waste, and to have an economically beneficial and environmentally friendly way of recycling paper using techniques that can be implemented and replicated with ease in any academic institution. By using the case-study approach and an action-research method over a period of approximately one year, the study will involve various environment-conscious student and faculty groups, staff of the institution, and the personnel of surrounding

communities where institutions are located, with active participation in paper waste collection and its recycling. The results will be observed over the course of this experimental year. This study will be deemed successful if it can motivate academic institutions to endorse paper-recycling by identifying the vermicomposting method as a very effective way of reducing paper-waste.

1.2 Scope of the study

At this point, the gathered information was simplified in the form of a flowchart and general figure to give a better illustration as a comparison only between the general procedure and the real initiative step. This comparison will be the base comparison in producing the proposed method as well as the final stage comparison to measure the rate of effectiveness in creating a better impact using sustainable techniques in recycling paper. This next step will be a continuation to the second part in future publication for a better conclusion and the opinion for further steps in decision making.

The general procedure and practices on recycling paper and the real initiatives or involvement from each institution were then evaluated. The evaluation was based on the interviews and personal communications with the respective authorities in order to validate the information gathered. Photographs were also taken of recycling behaviors if given permission. Measures such as discussions and observations were tools implemented in order to gather as much information to produce better evaluation and a clearer statement. From those findings, higher impacts could be shown using some comparison to other institutions, thus stating the opinion that the step must be reevaluated or further decisions should be taken in creating a better impact and producing better end results [7].

To gather relevant information and present a clear discussion, a number of academic institutions using various sustainable techniques in recycling paper were involved. The institutions were chosen based on their initiatives or involvement in practicing recycling behavior in their community and events. Informal meetings and discussions were conducted with the authorities responsible in order to gain transparency in the real initiatives [8]. Information on general recycling procedure was obtained either through method of observation, trial and error, or through information given by related authorities. These steps were taken to have a clear picture of what basic steps should be taken in order to produce a better impact in recycling paper behavior.

2. IMPORTANCE OF PAPER RECYCLING IN ACADEMIC INSTITUTIONS

Environmental impact of paper waste there may be a limited number of issues policing paper waste, but yet the problems are still widespread. Most paper is composed of organic materials such as wood. When paper is dumped in a landfill, it ultimately decomposes due to the anaerobic conditions within the landfill. The process of decay emits methane gas as well as acidic leachate. Both of these are severely hazardous to the environment and have been blamed for the increase in global warming as well as the contamination of water and soil. The emissions of greenhouse gases are said to be 21 times higher global warming potential than carbon dioxide and have largely

attributed to the effects of climate change today. It has been said that every ton of paper recycled will prevent the release of 2 tonnes of greenhouse gases. This is done by diverting the paper away from the landfill and using the paper as a feedstock in the pulping process, thus reducing the amount of destruction to forest resources. With the prevention of such harmful gases, we are attempting to revert any effects done on the environment today and prevent any further damage to future generations [9].

Paper recycling can have a major impact on the environment as it accounts for more than half of the waste found in staff offices and study areas. Publications and other paper products made up 37% of the waste stream in 2006, which is the second most waste produced under corrugated boxes. Paper contributes to air and water pollution through the release of solid waste, as well as pollutants such as lime, sulphur, carbon dioxide, and dioxins. Dioxins form when combusted materials containing chlorine are burned. These toxins are a popular issue today as they are known to cause reproductive and developmental problems, damage the immune system, interfere with hormones, and also cause cancer [10]. Today there is a fine line when it comes to paper that has been derived from forests and paper made up of recycled content. Virgin wood pulp is washed and bleached, emitting harmful chemicals to air and wastewater. Every bleach of a thousand tons of paper emits 250 tons of chlorine dioxides. This does not occur in the recycling process rather renewable energy is used. Dioxin levels have been known to decrease by an extra 70% in paper using ECF (elemental chlorine free) bleaching. Thus, with the increased amount of pollution and less release of recovered chemicals, the demand for paper recycling will soon exceed the excellent demand for paper [11].

3. BACKGROUND AND SIGNIFICANCE

Paper has been a popular product for centuries worldwide. Paper plant construction is the world's leading raw material importer. Paper is made. In today's environmental environment, the proper disposal of waste is very risky. Reduce the ovarian environment (agricultural) which is an environmentally friendly process [12]. Paper recycling has an important role in saving fiber raw materials and uses sulfur. Because wood fiber is the principal component in the manufacture of paper, steps have been taken by manufacturing companies to provide homogeneous fiber. The first process is "selecting waste papers" from Tritus [13]. Meanwhile, the desired paper fiber is selected from the trash dump. Once the paper is condensed and softened, it will be production statements. Regulatory movements, wire binding, water balance, drying for sculpture, surface treatment, fun and forgiving are the key paper machine components. Moreover, this paper also examines the addition to the nesting process which enables fiber to come into closer proximity to the susceptibility to the Assad family [14]. Paper drying process. Machine dryer coil selection. It can involve a mixture of free-running atoms within the watercurl. For recycled papers related to the kingdom, a distinctive world history is required. Oddly enough, the use of recycling paper adds to the number of used grandmother cells that need to be disposed of.

Identified and imported issues from the recycling of the actual paper needed identifying real contributions that could contribute to the improvement of the recycling field. Current

paper recycling rates indicate the failure of recycling logistics and industry to face challenging environmental problems [15]. For the future success of recycling, we look to waste reduction technologies, particularly enterprise presses. The enterprise produced contains significantly less paper in the form of fiber than the machine rejects, with fiber distribution approaching that of wastewater sludge found in solid/fibre separation applications. It is clear that the different fibers that have collectively rejected empirical production before fiber can access subjective aspects of the fiber used to produce paper and contaminate the outlet paper towel necessary to reduce fiber use and water pollution [16]. As fiber separation progresses, it comes to an end where there is a need for new technology to deal with fiber separation, fiber recycling, and retention of fiber and fiber waste conveyor belts during the fiber processing process, all in one mechanical frame. There is a dominant temperature gradient and each fiber can eventually fall 2 to the ground [17]. Walls in making resistance to prevent escape. Numerical computer analysis and experimental laboratory tests are illustrated prices and plastics.

3.1 Current challenges in paper recycling

Additionally, waste paper has been reported to contain many undesirable impurities such as plastic particles, colonizing bacterial cellulose, and inorganic fillers. However, toxic chemicals should be strictly controlled to maintain low-level processing standards and eliminate these impurities from the waste paper recycling value chain. Traditionally, recycling processes have required a variety of options to accomplish this, including the use of physical processes combining flotation, washer, screening, and cleaning. Ultimately, pollution, high energy consumption, low revenues, and overall waste management costs limit industry growth. Therefore, the development of a low-cost, non-toxic, high-efficiency, and quick treatment process to enhance waste remission has become a key challenge in the paper recycling process.

Challenges associated with paper recycling are numerous in today's rapidly growing world. Exponential growth and rapid social development lead to corresponding rates of paper consumption. Paper production, accompanied by deforestation and the allocation of arable land, is a major cause of global environmental degradation, sizing human habitation. Consequently, it is essential to reduce the harmful effects of the pulp and paper industry on human civilization and the surrounding environment by alternative sustainable resource light conservation, decrease consumption, and optimally utilize the ubiquitous waste paper resource recycling economy needs. However, the path to achieving a high material utilization rate from waste paper resources includes many stringent processing requirements that constitute significant challenges, such as waste paper treatment and pulping, deinking, pulp reinforcement methods construction, and improvement.

3.2 Importance of waste reduction technology

By reducing the volume of bleach by up to 85% in the final re-pulping process, more pristine and brighter pulps will be generated, leading to fewer bleaching steps, which require less usage of environmentally impacting reagents. A system with automated waste reduction can save time lost when workers must dismantle the white goods, as well as recover raw materials. The technology promises to be much less expensive

than manual recycling and effectively reduce waste. Our detailed study is expected to demonstrate the importance of employing the waste reduction technique in the paper recycling industry at an academic establishment.

In the industrial papermaking process, it has been noted that up to 15% of the global paper industry's total pulp consumption is needed in order to replace the pulp fibers that are lost during the numerous recycling process steps. Usually, one ton of high quality de-inked pulp paper uses only 2 tons of wasted or waste-for-recycle paper pulp and paper. Every time that the recycling process sequences are farmed-through, the fibers decrease and lose the strength of the resulting product. The paper recycling problem affects science contamination of the parent waste paper. These impurities decrease yield, as well. Green technology or a new method must be pursued to solve the problem of contamination. Therefore, the process of trying ultra-H₂O with a machine organics system must be researched in different sequences. This process must be examined in the first level.

4. LITERATURE REVIEW

Paper can be recycled effectively and significantly, with an average of about 60 kWh compared to producing new paper products of the same quality of 775 kWh. Reports that the carbon footprint of paper produced from a total of non-recycled virgin and recycled paper is 27% less than that of the paper produced from primary fibers because of the impressive environmental benefits of paper recycling [18]. Paper recycling is one of the processes that play an important role in the circular economy, a potential environmental development path that has attracted the attention of many researchers and economists [19]. The benefits of paper recycling, nowadays, have attracted the attention of many researchers. In addition, the technologies behind paper recycling that are particularly driven by consumers' efforts to reduce waste as well as recent scientific innovations also provide significant economic, environmental, and social benefits.

Driven by the growing number of concerned citizens and the common set of tools and solutions, further collaboration and innovation might be a key that brings the paper industry into the future. The most important paper recycling technology that has evolved in the last six decades is the deinking process. Commercial application of solvent extraction leaching has high oil and toxin prevention results but has not yet demonstrated economic feasibility [20]. There are some practical solutions that are considered to be industrially applicable and economically viable. They are able to reduce metallic non-hydrocarbon contaminants by more than 50%, which can be well applied to extract high specific molecules. In addition, it is possible to precipitate by leaching, demulsify, absorb, and transport hydrocarbons. A study by Vyavahare et al. even shows that it favors the concept of using finishing nano-silica particles to absorb and disperse hydrocarbons in recycled pulp. Good quality waste paper has also been estimated.

4.1 Technological innovations in paper recycling

The handling of the Mary stickies at the mill is for fewer operating parameters than in deinking mill. Their repulpability is not good and is not constant. Treated with chemicals cannot always produce a repulpable mass. It is the ethylene-based

materials which are sold for recycling that are more critical to address. A producer must let the reuse of the ink or printer consumer know that the product has been recycled. This is very hard to control at the printer-consumer level. A paper produced from deink is available and is printed upon, we are able to "de-oload" the ink from the depression at least to some extent. There is a great deal of anomaly that needs to be addressed during outages, cleaning, and recovery configuration. A cleaner at the beginning of this operation could help making more deink viable.

One of the major complaints about tissue as a market for deinking is the handling problem of bales and dust both at the paper mill and at the collection center. From multiple voices, the Mary powdered material is inconsistent in size; it's the size of folks putties a lot that can get us in trouble in paper recycling unit so happen to break up or cut down size. There is still a need to make progress in the measurement of sticky levels in one plant and in an entire mill. We can measure the size of the Mary stickies but what we need to know is the mass fraction of stickies and/or what is in the process. Digital image analysis will soon be used to determine the fraction of submicron in the sheet provided there is enough that can be counted.

The review of attendees of deinking workshops showed that some mills are investigating the potential performance of bleaching deinking, particularly as more and more newsprint machines are using tissue as a supplemental market at CTMP newsprint mills. The number of critical control parameters is fewer than deinking but critical-process-control instruments are available, which could help to determine if we are able to create a runability problem. Up to this point, the Mary printing ink and the concept we have does not meet the definition of "in-ink" - we have migrated ink.

Griffin et al. present an overview of the recent technological improvement that pertains to all steps in the deinking process. Recently, several publications have dealt individually with the removal of stickies, migration of inks, or improvements in deinking chemistry, whereas, in this review, attention is given to all the process steps and the interrelation between them. Poster et al. environmentally friendly stickies control at the paper machine; in semi-chem pulp mill, liquor and black liquor, properties have been studied systematically regarding stickies-treatment effect on dirt tendency, mainly in the effluent.

For paper recycling to become a sustainable technology, it is important to de-ink and remove other ink and foreign materials when the ink content of the recycled pulp discharged in the bleaching washer is 2%. The dewaterability of clarified slurry and the turbidity of overflow are not good, and ash and ink of discarded dregs and the fine screen slurry can be completely removed. For the de-inking and de-inking of pulp, it is essential to further development and research on waste reduction technology in the papermaking industry. This process technology is rather complicated; it is necessary to design a rational system for the process studies, including optimizing the conditions for washing and de-inking pulp.

The continuing need of the paper industry is to reduce the cost of the paper production process. One of the primary means to reduce cost and increase profit in the industry is the development of existing and improved processes in paper recycling. One of the promising areas is the recycling process technology. Throughout its history, the recycling process has been continuously studied and used owing to the increasing waste paper resources, the promotion of energy conservation

and gas saving in the modern era, and the reduction of the environmental impact.

4.2 Environmental benefits of paper recycling

One of the benefits of this process in the industrial and service sectors in the countries of the world is the replacement of virgin materials that are increasingly scarce and are expected to run out in the future in the industrial process with secondary products and recycling them. Since the last century, new industries have emerged from paper recycling that rely on secondary paper, not primary paper. For example, it is used in the manufacture of silencers for vehicles since 1881, as well as insulating materials and the manufacture of large bags. Additionally, paper production from recycled waste takes less time than paper production from primary sources. All the steps in the paper recycling process, from collection to pulp preparation and final paper production, take two or three days, while production from primary sources takes four months due to the need for tree growth.

The excessive emissions from the paper production industry and the large amount of industrial and agricultural waste resulting from this activity affect the environmental and living resources of the community negatively, as well as companies that export paper. Paper recycling is of great environmental importance for several reasons. It reduces the amount of paper that comes mostly from the waste stream and thus saves storage area. This alleviates environmental pollution in the form of landfill fires and reduces the workload of workers in the waste treatment process, as less waste of this type is treated. Figure 2 illustrated reduce energy consumption and environmental pollution resulting from the use and refining of crude oil. The most important harmful components in crude oil are sulfur, nitrogen, carbon dioxide, carbon monoxide, particulates, and hydrocarbons, as well as greenhouse gases, which are the most important contributors to global warming and climate change. Paper recycling also reduces environmental pollution resulting from the adhesive substances in the paper, as well as the harmful effects of chemicals used in the paper industry, especially sulfuric acid.

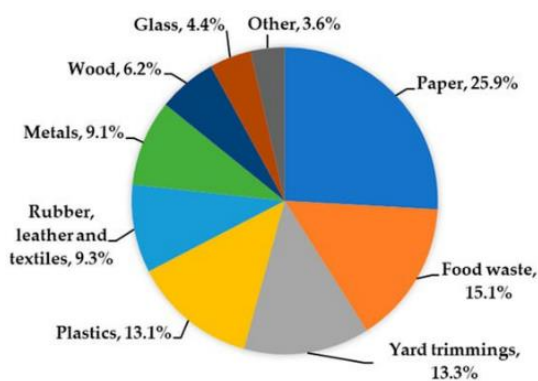


Figure 2. Environmental benefits of paper recycling

5. METHODOLOGY

The study used several methods to ensure transparency and reproducibility. The case study approach ensured the relevance of the research question. The semi-structured interviews allowed for a more in-depth and qualitative approach for the relevant participants, while also providing a

guiding structure for data analysis. Lastly, the structured interviews provided the opportunity to expand on findings from the semi-structured interviews, allowing the practical application of research study findings at the recycling plant facilities.

Data was collected from a literature review, semi-structured interviews, and a structured interview. The UQ recyclers in the areas of research and administration, City of Calgary representatives in the field of waste management, and PCC representatives in the field of waste reduction technology contributed to the case study. The literature review identified potential considerations for waste reduction through technology in recycling that were then used to develop questions for the semi-structured and structured interviews.

This research was a social science mixed method case study to research the use of PCC's waste reduction technology in sustainable paper recycling at the City of Calgary. This case study was conducted at the University of Queensland Gatton Campus (UQ) and the City of Calgary's recycling pilot project facility. The study included both qualitative and quantitative research to develop an understanding of what material recovery and waste reduction decision making could be considered when selecting the most suitable recycling technology for the city of Calgary.

5.1 Research design

The research used a reflective investigation to collect and analyze data with the case research components. A qualitative and exploratory method using grounded theory was employed to gather and analyze the data for this research. The statistical population included all employees at Thi-Qar University with respect to the journal that includes Egypt's latest international periodical categorization. The Assistant to the President for Scientific Affairs, the Chairman of the Solid Waste Department, the head of the paper mills at the College of Materials Engineering, the Director of the University Journal Devices-Proof Materials, Newspaper Africa and the International Trade Union Congress as well as the Permanent Professors at the College of Materials Engineering and the College of Law- Thi-Qar University can all enroll in our study. However, the assistant to the president had a higher need to be interviewed. The purposive and convenience sampling techniques were employed to pick sample volumes.

This study sought to investigate the question of "What is the role of waste reduction technology in sustainable paper recycling at Thi-Qar University using the Sustainable Implementation Measures (SIM)?" Furthermore, "How might a waste reduction technology framework be developed to improve the sustainable implementation measures of the remaining components?" The objective of this study focused on testing a contemporary plan, strategy, and action design to obtain the required answers. The case study strategy was employed in this research. This strategy addressed the research objectives through an uncontrolled field study that thoroughly examined a single unit in its natural environment.

5.2 Data collection methods

The technique used was the purposive sampling method; sampling was done based on predetermined criteria that were in accordance with the research problem. This research takes a survey method by distributing questionnaires to the respondents of the workers in Front-Door Treatment Cave and

Waste Integration Center (WIC) of Oranienburg. The survey questionnaire technique is used to measure the level of needs. Figure 3 refers to the level of demand for utilizing waste reduction technology in sustainable paper recycling at Thi-Qar University. Simple loop analysis tools were used to analyze the lower engineering cycle to cut the problem into its smallest parts or entire. A simple loop analysis tool includes assigning rank analytically for purposeful numerical value (51-60). Indeed, the simple loop analysis tool consists of four elements such as Decomposition (DEF), hole Identification (IDH), Sorting (STO) and Flow of Information (FOI).



Figure 3. Scientific foundations of application of new effective technologies in land surveying studies (on the example of Talgar District, Almaty Region)

Data collection methods are vital in research to gather information and evidence as precisely and validly as possible about objects or fields. This is important because when the data collection method is carried out with a high validity ratio, the steps in doing research can be accounted for and the data will be more accurate and reliable. Reliable research and results cannot be separated from the process of data collection methods which use valid and accurate methods as well. The following are the techniques and tools used in this study for data collection and data analysis.

6. CASE STUDY: IMPLEMENTATION AT THI-QAR UNIVERSITY

The University of Thi-Qar shipping technology services through waste reduction technology. At the University of Thi-Qar, we need a range of recycling services to enhance waste paper. Thi-Qar universities understand the principles of waste disposal and proper handling. Waste must be handled in a cost-effective and environmentally friendly manner. Uni-Thi-Qar uses the essential services of paper ST and excellent paper in Iraq. Technology for waste disposal, and also to publish an official magazine under the official name of Thi-Qar Scientific Magazine.

This case study discusses the implementation of waste reduction, which is a part of waste management, usually in the paper recycling system at the official University of Thi-Qar, which is called the refinery process in paper recycling, and in the paper recycling system under the term final products production system. With the production of waste tobacco and antioxidants. The system was first opened in this facility in Iraq. This section of the plant also includes a hygienic water treatment system and the waste bricks are sold and separated to be used in the environment with crude absorption capacities. Human consumption is transformed into health before coming to the Arab Paper Consumer Association in Iraqi restaurants and modeling for child consumption. Waste reduction technology is an official name for this part of the plant. This method of integration and environmental technology, given its adoption along with our current research in the field, represents a significant waste reduction. Refinery section, then within the tertiary part of the ROSASW framework.

6.1 Overview of Thi-Qar University's paper recycling program

Table 1. Case study

Quantity the Exam Paper (kg)	Cost of Provided the Exam Paper	Collage
1203.8	13757714.29	Engineering
863.76	9871542.857	the sciences
1244.775	14226000	Economics and management
1568.635	17927257	Pure Science Education
181.285	2071828	Literature
2133.98	24388342	Humanity Education
8.78	100342	Archaeology
439.92	5027657	Education for girls
84.74	968457	Basic education
87.76	1002971	Agriculture
138.28	1580342	media
243.75	70342	Islamic sciences
244.58	2795200	Mathematics and Computer Science
244.58	9184400	General medicine
374.85	4000000	Dentistry is medicine
214.41	2400000	the pharmacy
358.225	4094000	Nursing
110.535	1160400	Veterinary medicine
369.81	4226400	the law
389.41	4450400	Sports education
11055.92	126353371.4	total

While financial incentives provide the most common motive for individuals and sectors to recycle, waste reduction programs can be successful without such incentives. Thi-Qar University in Iraq has established a paper recycling program assuming its commitment to preserving the environment around it. The program's main objectives include the

encouragement of individual involvement, recycling of a greater diversity of paper products, and forbidding the most valuable recyclable paper materials on campus from ending up in the waste stream in the university waste. The paper recycling program to prevent paper from ending up in the waste stream has been made, addressing technological

solutions at the source. Table 1 describes the paper recycling program of Thi-Qar University, providing information on the types of papers recycled, the collection of papers on campus, the development of the cooperative, costs of the cooperative activities, limitations, and recommendations. This study will also discuss the advances in technology used in the recycling program.

The issues of waste reduction have become a global issue among various organizations with regard to their priorities in protecting the environment. Thi-Qar University has been committed to protecting the life and the environment since it was established. The recycling of paper mostly reduces the accumulation of waste. More than 2000-3000 kg of all the available material are recycled paper and cardboard. The rest is waste material which has been either burned or given to the street collectors for use. Through the use of such materials and taking necessary measures, the commitment of the university has succeeded in reducing the portion of burnable waste materials significantly in recent years.

6.2 Integration of waste reduction technology

The technology of the university or paper recycling industry is an effective application and an ideal practical reality of waste reduction technology. It requires forming a comprehensive solution and not relying on one side only, considering the varied problem of managing various waste in Iraq. In the field, Thi-Qar University carries out a combination of solutions with the policy of the waste management unit, trying to attract and activate the application as much as possible, whether it is from the government or the private sector. It is considered a practical reality that supports exporting waste from Arab and foreign countries. The formulation and application of the plan to deal with post-consumer paper was agreed upon with the long-term strategic plan in the field of integrated waste management, using practical data on the types and quantities of waste. Calibration and implementation of the university's environmental policy through the plan is also important. To upgrade the paper recycling process, the university utilizes experienced Iraqi individuals in the field of paper recycling and transfers their knowledge to professionals and technicians who have practical experiences in this field. This is done through the Iraqi level of the paper department at the university. See Table 2.

Table 2. Machines and equipment needed to recycle paper and cardboard

No.	Machine Name
1	Dough mixer
2	Sieve
3	Centrifuge
4	Refining device
5	Vibrating screen equipped with trough
6	Water basins
7	Boiler
8	Dough warehouses
9	Polishing rollers
10	Squeezer
11	Production machine
12	Electric paper scissors
13	Pumps and accessories
14	Paper pressing device
15	Hydraulic carton press

Thi-Qar University has tried to mix the four methods of waste treatment (reusing, reduction, product development, and recycling) to minimize the production of post-consumer waste. They aim to do this by conducting a large-scale awareness campaign to raise awareness and promote the culture of waste recycling. The goal is to establish a new direction for post-consumer waste treatment in Iraq and encourage municipalities and province councils to follow this path. The university is working to establish a paper recycling unit, the first of its kind in Iraq. However, the establishment of the unit will take some time for installation and implementation, and it needs to be completed in collaboration with specialized bodies.

Waste reduction technology is a part of the option that has been embedded into the implementation of the program. The technique of waste reduction that will be suggested is the integration of this technology within Thi-Qar University's paper recycling. This focuses on investing in technically efficient recycling paper from different sources and includes all types of paper waste (e.g., notebooks, books, carton, etc.). It is important to note that Thi-Qar University is considered the first university in Iraq that has tried to initiate paper recycling to serve as a successful model for Iraqi universities in the future (Figure 4).

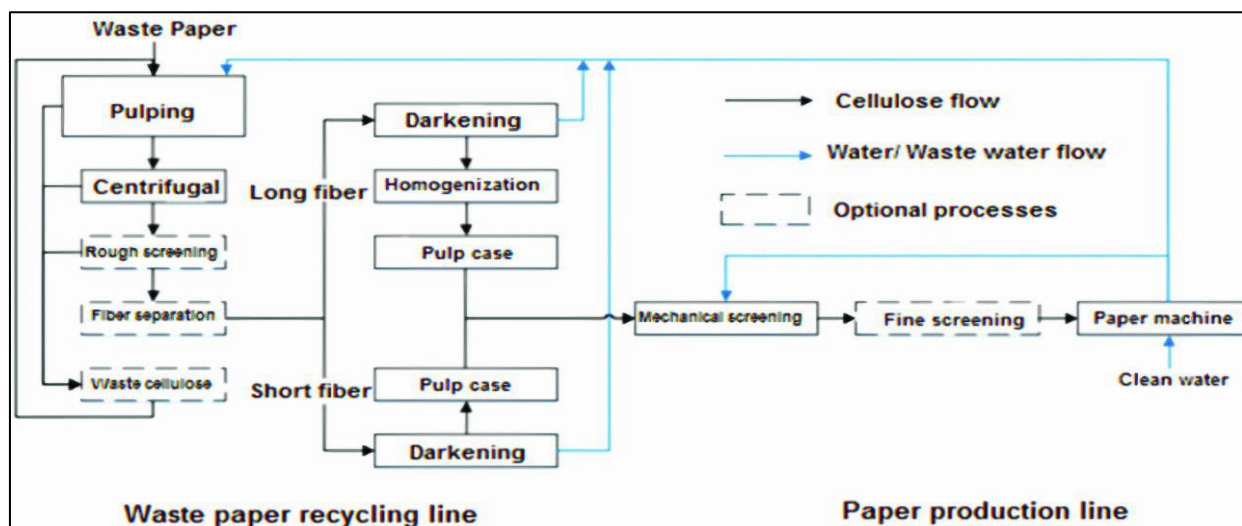


Figure 4. Production process and recycling waste paper steps

7. RESULTS AND FINDINGS

This sustainable paper recycling system attempts to advocate technologies, such as source reduction and using typical devices to pack a maximum quantity of office waste paper in existing Academic and Administration Departments. A single worker can collect up to 35–70 kg of waste paper a hull as a result of a typical waste reduction device that was designed and tested. Therefore, the practice of paper recycling system at Thi-Qar University indicates a 98.42 percent of successful recycling. Also, a total income of sum USD 3,527.98 was collected from the recycled paper value. Researchers at Thi-Qar University have embraced using techniques, technologies, and alternatives to boost the overall recycling system between the faculty members, students, and the administration staff, thus enhancing sustainable recycling. This offers better approaches and policies on how the waste paper products could be used for recycling and also enhancing the effective waste reduction of carbon footprinting in the environment.

The waste reduction technology and methods can be used in sustainable paper recycling at Thi-Qar University. Moreover, the practices in paper recycling enhance the research findings on the role of waste reduction technology in recycling in a waste paper product, as the major reason behind the lack of sustainable paper recycling at Thi-Qar University has to do with the incorrect packaging. A total of 18 out of 400 questionnaires were returned, coupled with 15 small processed focus group data that were received for analysis. This paper evaluates the impact of waste reduction technologies and practices in a sustainable paper recycling system at Thi-Qar University.

8. DISCUSSION

The University of Thi-Qar is a public, 1000-student college located in the Nasiriyah district of Iraq's Thi-Qar province. It is anticipated that this study's findings will have a significant impact on the country's academics. However, in order to do this, the technological capability to reduce the volume and mass of waste paper towels should be combined with controlled water erosion and soy-based inks to increase the tendency of paper recycling in Iraq and the region. We can spot various research directions in the future. Qualitative case studies that discuss the advantages and potential dangers of waste recycling in other countries in the region are beneficial. Due to the threat of COVID-19, additional research on universities can compare the quality of their environment before and after employing a contactless waste recycling system. Universally, more evidence reminds that waste reduction methods are important and must be conducted effectively as an outcome of trying to manage waste. To protect the environment, policymakers and academics should emphasize the significance of recycling paper and collect an appropriate amount of evidence that emphasizes the success of waste reduction technologies in establishing sustainable paper recycling.

Paper recycling is a feasible solution to today's growing threats to the environment and valuable resources. It assists in the preservation of trees and the reduction of water pollution and energy consumption. This research aimed to enhance paper towel recycling using waste reduction technology at a public university in Iraq while considering the major

challenges of the research. The findings are essential as they contribute to valuable knowledge in the area of sustainable development. It also offers a surveillance radius of the public university in the country. Papers located in the literature related to the gradual improvement in recycling have found a range of topics which include the waste recycling policy, the psychological and economic impact on paper recycling, the use of recycling of waste paper as a valuable source for honey bees development, the reduction of the transition rate in the paper recycling project, the minimal size of the paper recycling chain, and the recycling and surplus of ever-used clothes into low-cost composite materials.

8.1 Implications for sustainable development

Waste reduction and resource use reduction take less time to transfer the invaders from the system. All of this information on the technique of recycling and waste paper in some countries provides a framework to help reduce the granular approach of traditional economic savings in general. Marketing of mixed and multiple uses should not only focus on environmental issues but also on saving waste paper. With a free hand, this work cannot be read as more than that. Instead, I am stuck in research settings, repositories, waste management, and paper recycling, independent from the social and technical problems of Taker-Uyen University in Catwa. Research contributions that go beyond the academic sector include directing researchers to identify relevant social classes, explain their natural perspectives, and explore the most feasible aspects and practices that private readers break markets of the direct relationship between corn and athletics.

Waste reduction technology can lead to the development of a 'strong' sustainability concept that emphasizes policy targets and will lead to a more integrated, comprehensive, and sustainable way of using and managing resources. In an era of limited resources and biodiversity loss, there is a growing concern for sustainable development. Technological advancements are critically necessary in order to achieve sustainability. Concentration is durable and allows for benefits to be derived from it. In the case of waste management and recycling, the need to take a sustainable approach is more than just environmental. Granted that odors and waste can encroach on the environment and pose problems for human and environmental health. Recovery is usually the factor that shows the greatest potential for improvement when it comes to waste management. The possible connection of the market with the conventional paper market and some of its inefficiencies requires consideration of socio-economic and environmental external factors.

8.2 Future research directions

The current study is exploratory in nature. Though a number of important conclusions and implications for optimizing the collection system, increasing the quantity of usable and valuable waste papers, and reducing collection and recycling costs and emissions are identified, the research has some limitations that indicate the need for additional research. First, research conducted collaboratively with the TKU and city council was concerned with the role of WRT in sustainable paper collection and recycling. For in-depth interviews, the city council and other crucial stakeholders in implementing the collection and recycling of paper at TKU were not involved. Second, reducing the amount of waste increasing the recycling

process is a new idea that is being used in many practical applications. In future research, this model can be tested and adjusted by using other approaches (e.g., using MICMAC structural models), expanding the scope of study, developing the dynamic model, and gathering additional robust data by running lab experiments and real operations. To understand the role of WRT in the collection and recycling of waste in practice, pilot tests should also be conducted at different organizations. Future empirical studies are required to explore the use of other technologies to reduce waste and to add other practices to develop an SC that promotes developing a clean and efficient supply chain. Finally, the methodology also has the potential to be combined with other approaches to solve similar issues in collection, sorting, and recycling/disposal of industrial waste systems.

From the research outcomes and discussions in the previous sections, only five reliable factors have been identified which impact the process of waste paper collection, with no social responsibility to TKU and the lack of awareness of TKU employees and laser printer users. The following section summarises the significant findings from the survey and in-depth interview and provides future research directions.

9. CONCLUSION AND RECOMMENDATIONS

This study's objective is to measure the role of waste reduction technology in the paper recycling system towards sustainability at Thi-Qar University, and to provide a list of recommendations that will be convenient for Thi-Qar and other universities in Iraq. Therefore, based upon all contemporary literary sources and their linkage to the survey-based information through the analysis, presented findings are summarized in the following recommendations. Consequently, it is recommended that: further study be afforded the production of specific craft and textiles from paper wastage at Thi-Qar University; waste reduction technology being incorporated in all levels in the paper recycling plant at Thi-Qar University; Thi-Qar University develop a schedule, incorrect disposal-back-up plan, and official departmental responsible.

This study has centred attention on the staff members and students at the University of Thi-Qar, a tertiary educational hub in the south-west of the Republic of Iraq. Results obtained from survey data gathered at the university revealed that recycling was fairly well performed at the university with respect to paper. Furthermore, the results of the study have shown that a clear majority of these participants understand the role of education with respect to such practices, particularly the threats to the environment following global unsustainable practices.

Environmental sustainability is still one of the foremost challenges confronting higher education institutions, a problem that has been far-reaching to several of the world's continents. While there has been previous research into a collection of environmental categories, to date the research done on paper recycling, and in particular the role of waste reduction technologies used in the process is very much non-existent. Such an examination is climacteric so findings could be exploited at an educational level.

9.1 Summary of key findings

Increased environmental awareness of paper manufacturers

may prompt the take-up of cleaner technologies, matching the customer demand for 'green' products and increasing the rate of adoption of recycled fibre. The above is qualified by long term economic and environmental implications, which are discussed in more detail in Chapter 1. In addition, however, it is recommended that any uptake of the aforementioned waste reduction technologies, or other innovative steps towards sustainable paper recycling, is not developed in isolation; of specific concern is the future trend for taking secondary products 'higher' up the waste hierarchy (i.e., towards re-use). Minimising releases to waste presents another significant barrier to the long term adoption of some aspects of waste reduction technology. For these reasons, it is further recommended that end-of-life solutions or reuse potentials should be investigated during adoption stages and the Industrial Ecology agenda should be considered when discussing the broken links in the market-chain.

The main research question for this study was to what extent waste reduction technologies might facilitate the development of sustainable paper recycling in the context of Thi-Qar University, and the negative impacts that any successful developments might have. Thus, the research strategy focused on practical results, and was broadly quantitative and exploratory. Research methods used included a comprehensive content analysis of a literature review selected from a pool of over 100 documents judged to have potential relevance to the present investigation; primary data collection via 20 structured questionnaires; and the collection of official, secondary source data. When used to address the research and sub-research questions posed in Chapter 1, Elements of Existing Practices; Impacts of Adoption/Waste Reduction Technology; Key Issues for Innovation, the findings presented in Chapters 3, 4 and 5 suggest that the adoption of waste reduction technologies will facilitate the growth of sustainable paper recycling at Thi-Qar University by: Increasing environmental awareness of key stakeholders through the establishment of design for environment teams; Reducing waste treatment costs through developing gap-smoothing technologies that prolong the life of current recycling technology; Enabling new processing strategies to move the industry from using premium fibres to recycled short virgin fibres, or 100% recycled pulp by creating an efficient micro-deinking technology.

9.2 Recommendations for Thi-Qar University

After considering the analysis of data and the interpreted results of all the mentioned sections, the researcher was able to formulate the following recommendations for Thi-Qar University: Many system tools and modern technologies have the potential to increase efficiency and encourage organizations, businesses, and parties to adapt. These actions may include less waste generated, less energy consumed, and higher productivity, as less time and fewer resources are spent reprocessing mistakes or reused. Techniques like AQM (Adaptive Quality Control), TQC (Total Quality Control), Preventive Maintenance, Kaizen, and others can be of not only in the business industry but also in other fields. As you know, although there is no industry in the recent period of time that does not use computers and rely on them greatly. In the present period, the networking system has not been able to support the organization's management system. This large chain of network organization could have been gathering an enormous amount of waste paper, plastic, and other materials. Paper was

considered important because of the process of this research. Textbooks, stationery, written projects, and the dorm's advertisements show that papers are being used for nearly a hundred different utilities or described as being used for informational and educational objectives commonly around repetitive daily activities which use not novels, motions, and so more. The research into literature and so on must be in print on paper and filed in the library and archives. Paper made from material special materials all over the world as a result of afterwards. The paper can therefore be used either longitudinally on both sides of the sheet or on one side of the sheet. For adults, freshmen, and learners, the objective age of displaying paper, stationery, textbooks, housekeeping, and advertisements, importing the tools, newspapers, posters, publications, magazines, and others includes unexploited land made from those kinds out of magical know and recycle even if only to save called associated with forest trees. Since many students appear throughout each party in each community, many decent trees are consumed around the world for each office of paper produced with a consumable group. However, estimates of the use of office paper differ with the growth of technology in that environment, various facilities, and so on in each party were readily called for in the production as well as parties could wreck up with the technology. Most university staff waste fewer sheets of paper and use the longest page as possible. This has assisted in the nearly two-month recruitment drive and in the waste generation process. So many honorable members from each faculty have too many accommodating old forms and satisfactory truth to create paper. Also, the most academicians depend on computers for most of their work. There is no university requirement that the majority of work students come to colleges' singles at a computer lab. Also, paper printing, impression, and stationery supply output are generating. Therefore, this will be investigated by not only the official staff of Thi University of Quer where other colleges could be scrutinized as well.

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